National Aeronautics and
Space Administration

**Headquarters**
Washington, DC 20546-0001

February 10, 2023

Reply to Attn of: SMD/Earth Science Division

Dear GLOBE Community,

I'm pleased to share with you the "GLOBE Informal/Formal K-12 Comprehensive Education Pre-Evaluation Activities" Report Brief. This report was prepared by a third-party independent evaluator with expertise in education evaluation led by Dr. Carla Johnson, who at the time was at Paragon TEC. I am excited to share these evaluation findings with our entire GLOBE community as we work together to build on GLOBE's nearly 30 years of impactful programming.

During the 2022 GLOBE Annual Meeting, I shared that the GLOBE Program Office (GPO) initiated the first set of activities to support a program-level evaluation. This first step specifically focused on the development of a baseline assessment for GLOBE's activities and reach in informal and formal K-12 educational settings in the U.S. The overarching goal of investing in evaluation activities is to understand outcomes from the program, which in turn can serve as an evidence base for the program and inform continuous program improvement.

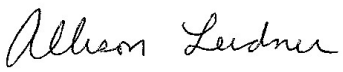
The Report Brief, which is an executive summary of this first stage of the evaluation findings, highlights many strengths of the program and identifies several opportunities for further growth. This initial activity had a scope that primarily considered materials available to the program as a whole – such as the Teacher's Guide – rather than the activities conducted by individual U.S. and country Partners. Thus, we know the Report Brief findings did not synthesize all the amazing work carried out by GLOBE Partners. GPO, the GLOBE Implementation Office (GIO), the Data Information Systems (DIS) team, the U.S. Country Coordinator Office, and NASA are well-aware of the work you are doing across the U.S. and around the world, even if this report indicates that a specific region had less activity or that GLOBE is not addressing certain topics.

As we digest the results of this report, we are also looking to the future. First, GPO will further invest in evaluation activities, considering all aspects of GLOBE, so we can continually improve the program. As resources permit, we will look to develop a program-level evaluation strategy and plan. Second, we are developing a GLOBE Evaluators Community of Practice where GLOBE Program evaluation practitioners can share resources, experiences, and best practices on evaluation methodology. The community of practice will be piloted in the US. It is not a replacement for the Evaluation Working Group, whose members help identify evaluation needs, bring forward ongoing evaluation activities, and disseminate evaluation findings to the GLOBE community. Third, we will make iterative improvements about how we collect data on Partner activities so we can deepen our understanding of GLOBE's impact. Fourth, we will increase our

investment in a U.S. Country Coordinator Office so that it is better staffed to provide strategic support to U.S. Partners.

I want to conclude by thanking the many members of the GLOBE community who directly and indirectly contributed their knowledge to this first round of evaluation activities. I am inspired every day by the commitment and accomplishments of the GLOBE community.

Sincerely,



Allison Leidner, Ph.D.
Program Scientist, GLOBE
NASA Earth Science Division

# Report Brief:
## GLOBE Informal/Formal K-12 Comprehensive Education – Pre-Evaluation Activities

***Prepared by Paragon TEC, Inc.***
December 2022

The GLOBE Program is a worldwide science and education program (GLOBE Home Page - GLOBE.gov). The purpose of the overall 2022 GLOBE K-12 Informal/Formal Education Comprehensive Evaluation pre-evaluation activities were to examine GLOBE's K-12 formal and informal education programming with the aim of providing a foundation for an evaluation framework that would be developed to guide future evaluations of GLOBE K-12 programming. GLOBE's K-12 educational initiatives engage schools, informal/formal educators, and students via a network of U.S. and international partners to collectively engage in research and data collection with real-world purpose and utility. GLOBE activities introduce K-12 students in the U.S. and globally to important Earth systems science content and concepts and provide opportunities for students to apply their knowledge and skills in Earth systems science. GLOBE also provides teacher professional development training to prepare teachers to enact the program with fidelity. Evaluation of other aspects of the GLOBE program, including citizen science activities targeted to those outside of a K-12 age range (typically 5 – 18), program managerial structure and operations, and diplomatic and cultural exchanges, were beyond the purview of this evaluation activity.

Pre-evaluation activities encompassed five tasks that collectively informed a program design analysis (PDA) report (see Figure 1). The purpose of a program design assessment (PDA) is to develop a baseline assessment of a program regarding one or more of the following: program operational aspects, program curricular aspects, participant data/reach, and program impacts on desired outcomes. The first task was a benchmarking study and literature review which were conducted in order to understand effective practices in the field and to identify evidence that could inform GLOBE's K-12 educational efforts. An analysis of historical program-provided data was also conducted in order to understand the reach of GLOBE across the U.S. Next, a GLOBE internal stakeholder forum (ISF) was held in order to elicit stakeholder perceptions as an important data source for the PDA. Finally, a document analysis was conducted that reviewed publicly available information about GLOBE's K-12 educational initiatives and program-provided educational documents and prior evaluation information.

It should be noted that these tasks focused on GLOBE's activities at the national (U.S.) level and assessed information provided by the GLOBE Program Office. As such, the tasks did not include analysis of exhaustive partner-level activities, products, or initiatives. The following sections overview each of the five tasks and the key takeaways associated with each. These tasks and the takeaways were used to inform the final PDA report.

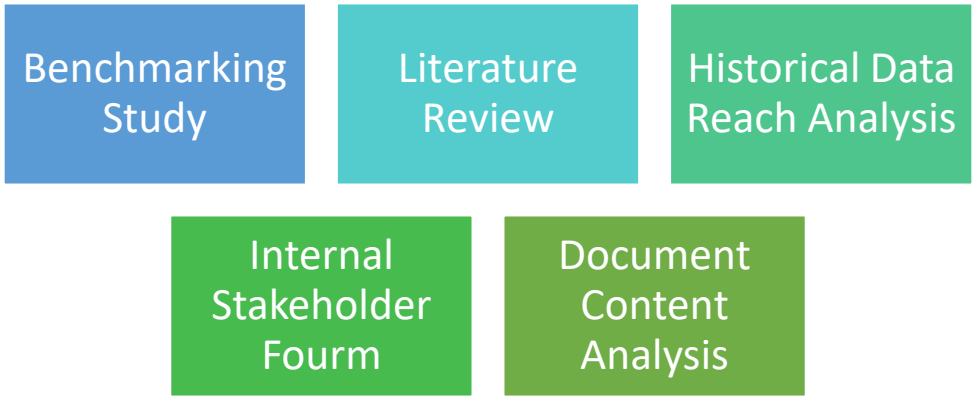



**Figure 1.** ***Summary of Pre-Evaluation Activities Which Informed the PDA***

## BENCHMARKING STUDY

The GLOBE benchmarking study aimed to identify programs with aims and structure similar to GLOBE and to understand how these programs' activities and structures compare to GLOBE's activities and structure. A review of these programs selected on the basis of similarity in K-12 educational aims (inquiry learning in environmental science) and structure (provide structured K-12 curricular materials) indicated that GLOBE is unique in its reach, structure, and scale. A sample of six programs that exhibited similarities to GLOBE's K-12 programming in one or more aspects were selected for the benchmarking study (Table 1).

**Table 1.** ***Sample Programs Exhibiting Features Similar to GLOBE***

| Program Name, Sponsor, Type | Website and Program Description |
|---|---|
| **LiMPETS – NOAA** ***Program*** | https://limpets.org/ LiMPETS is a regional citizen science program that monitors the coastal ecosystems of California and helps youth develop a scientific understanding of the ocean. |
| **CoCoRaHS – NOAA and NSF with Partners** ***Program*** | https://cocorahs.org/ CoCoRaHS (pronounced KO-ko-rozz) is a grassroots volunteer network of backyard weather observers of all ages and backgrounds working together to measure and map precipitation (rain, hail, and snow) in their local communities. |
| **National Estuarine Research Reserve System (NERRS) – NOAA** ***Multiple Resources*** | https://coast.noaa.gov/estuaries/ On this site, educators and estuary enthusiasts will find a variety of resources, including specially developed activities, animations, videos, teacher training workshops, real-time data, and opportunities to volunteer at a local reserve. NERRS has curriculum, data "Graphing and Export System", and teacher training workshops. |
| **Building Learners – U.S. Green Building Council** ***Curriculum and Data Collection Portal*** | https://learninglab.usgbc.org/building-learners Building Learners is a K-12 education program that uses the operations of a school building to teach students about sustainability and empowers students to use their building as a learning laboratory. |

| Program Name, Sponsor, Type | Website and Program Description |
|---|---|
| **EnviroAtlas – Environmental Protection Agency** ***Curriculum and Mapping Application*** | https://www.epa.gov/enviroatlas<br>EnviroAtlas materials use a blended learning format to allow students to investigate local, environmental issues using online technology.<br>The EnviroAtlas Interactive Map puts hundreds of geospatial layers on environmental conditions, uses, and stressors, transparent metadata, and socioeconomic overlay capability at the fingertips of anyone with internet access. |
| **Meaningful Watershed Educational Experience (MWEE) – NOAA** ***Instructional Framework*** | https://www.noaa.gov/education/explainers/noaa-meaningful-watershed-educational-experience<br>The Meaningful Watershed Educational Experience (MWEE) is a learner-centered framework that focuses on investigations into local environmental issues and leads to informed action. MWEEs are composed of multiple components that include learning both outdoors and, in the classroom, and are designed to increase the environmental literacy of all participants by actively engaging students in building knowledge and meaning through hands-on experiences. |

The findings of the benchmarking process revealed that GLOBE is a unique program that fills a gap in access to authentic science experiences for students in K-12 schools around the world. The benchmarking study highlighted the uniqueness of GLOBE relative to other programs. Key takeaways from the benchmarking study are displayed in Table 2.

**Table 2.** ***GLOBE Benchmarking Study – Key Takeaways***

| Key Takeaways – GLOBE Benchmarking Study |
|---|
| GLOBE K-12 initiatives are unique in the following structural characteristics:<br>• K-12 activities and curricula are free of charge;<br>• K-12 activities provide curricula and activities with an expansive lens on environmental and Earth science that is applicable across a wide range of geographic settings;<br>• and, K-12 activities engage students in working with STEM professionals and/or partners to collect and upload Earth science observations. |
| GLOBE K-12 initiatives are unique in terms of the following characteristics of reach:<br>• GLOBE K-12 activities engage students globally;<br>• and, the level of participation in GLOBE annually (measured by the number of schools, teachers, and students participating) far surpasses that of any other program identified based upon publicly available data. |

# LITERATURE REVIEW

The purpose of the literature review was to identify and understand practices that support effective teaching and learning practices in K-12 STEM generally and, more specifically, within environmental science, that could inform GLOBE's K-12 programming. The review sought evidence for effective instructional practices in K-12 informal and formal learning, for engaging a diverse population of students in STEM learning, and for evaluating student outcomes. Employing a utilization-focused approach to evaluation (Patton, 2015), the review sought to identify literature that synthesized or reviewed the extant evidence regarding the following research question: What are best practices for K-12 STEM teaching and learning, and for teaching and learning in environmental science in particular?

The literature review identified effective practices for STEM instruction, for narrowing the persistent achievement gap in STEM, for evaluating STEM outcomes, and for adapting curricular materials across languages and cultures. Key takeaways from the literature review are displayed in Table 3.

**Table 3.** ***Literature Review – Key Takeaways***

| Key Takeaways – Literature Review |
|---|
| In ALL INSTRUCTIONAL SETTINGS (formal, informal, or out-of-school time (OST), and environmental science), **instruction employing active learning strategies** - including inquiry learning, problem- or project-based learning, argumentation, and science and engineering practices - supports positive student outcomes such as gains in content knowledge, interest, STEM identity, science competencies and skills, and 21st century skills. |
| In ALL INSTRUCTIONAL SETTINGS (formal, OST, and environmental science), **instruction that grounds content in authentic contexts** supports positive student outcomes, including gains in content knowledge, interest, STEM identity, science competencies and skills, 21st century skills, and can provide important educational and career information to students. |
| In ALL INSTRUCTIONAL SETTINGS (formal, OST, and environmental science), **instruction incorporating strategies associated with culturally relevant pedagogy** - including collaborative learning, integration of culturally relevant content, educator training in culturally relevant pedagogy, and provision of culturally relevant role models - can engage students from diverse backgrounds in STEM learning, support students' STEM identities, improve academic outcomes, and foster interest in STEM careers. |
| **Informal or OST settings offer particular affordances** in providing students with access to active learning in authentic contexts and provide opportunities to engage community partners and are particularly effective when program content and goals are aligned with students' in-school learning. |
| **Environmental science programs provide particular affordances for student learning and for engaging diverse students** because of their connections to local contexts and their focus on inquiry. |
| **Although a complex range of factors impacts the STEM achievement gap, the following strategies support STEM learning for students in groups historically underrepresented in STEM:** active learning, ensuring that materials and instruction are culturally relevant, grounding content in authentic contexts, providing educator professional development in content and pedagogy, and engaging culturally relevant mentors and role models. |
| **Evaluation of student outcomes in K-12 STEM programs must be carefully crafted to match constructs assessed to program content and objectives.** Various tools and methods can be used to evaluate student outcomes such as knowledge and skill gains, and changes in attitudes and dispositions. Student outcomes |

| Key Takeaways – Literature Review |
|---|
| in these areas can be measured using the following: summative learning assessments; pre-and post-tests, and dispositions; observations; survey instruments; and analysis of student products. |
| **There is a particular need for high quality, flexible instruments to measure student outcomes in OST settings**, including those to facilitate longitudinal and large-scale evaluations. |
| IN ALL SETTINGS (formal, OST, and environmental science), **access to high quality curricular materials available in a learner's native language and appropriate to their cultural context** is key to maximizing learners' comprehension where the goal is content knowledge acquisition rather than acquisition of a second language. New materials should be developed with input from globally diverse content specialists and educators and with attention to designing materials that can be adapted to various local contexts. Translation efforts should account for the cultural context in which materials will be used. |

# HISTORICAL DATA REACH REPORT

The historical data reach report included an examination of GLOBE program provided electronic (Excel) data files related to GLOBE K-12 school participation and U.S. and international partner data. These data were analyzed to produce an overview of the demographic reach for active K-12 schools in the 2017-18 and 2020-2021 school years and active partner participation data for 2011-2021. School participation data for the two timeframes were matched to school-level demographic data using National Center for Education Statistics (NCES) identifiers. For this analysis, GLOBE schools were defined as active if they submitted at least one scientific record during a study year (2017, 2018, 2020, 2021) in the form of a report (i.e., student research report, International Virtual Science Symposium (IVSS) submission, a U.S. Student Research Symposium (SRS) report, and/or mission mosquito report) or observations resulting from any GLOBE protocol. In the U.S., partnered schools are defined as schools that had an affiliation listed with a GLOBE U.S. partner, based on information available in the GLOBE Data and Information System. Some schools were active but did not have a U.S. Partner listed. Internationally, all schools were considered partnered, as by definition all schools in a given country are part of a country's GLOBE partnership.

Findings for active GLOBE schools in the U.S. during the designated timeframes is provided in Table 4. Findings for GLOBE partnerships with K-12 schools and organizations in the U.S. from 2011 to 2021 is provided in Table 5 and Figure 2. Findings for GLOBE partnerships with informal K-12 settings in the U.S. is provided in Table 6 and Figure 3.

**Table 4.** ***GLOBE Active U.S. Schools in Academic Years 2017-18 and 2020-21***

| School Characteristics | Active Schools AY 2017-18 (*n*=535) | Active Schools AY 2020-21 (*n*=328) |
|---|---|---|
| **School Type** | | |
| Public Schools | 91.2% (488) | 85.7% (281) |
| Private Schools | 8.8% (47) | 14.3% (47) |
| **Partnerships** | | |
| Schools with GLOBE Partner | 84.3% (451) | 86.0% (282) |
| Schools without GLOBE Partner | 15.7% (84) | 14.0% (46) |

| School-Level Demographics by School Type and/or Setting | % Matched Active Schools | |
|---|---|---|
| | AY17-18 | AY20-21 |
| **Racial/Ethnic Minority Demographics** | | |
| All Schools | 40.0% | 47.7% |
| Public Schools Only | 40.6% | 48.8% |
| Private Schools Only | 24.0% | 24.1% |
| **Urban & Rural School Settings** | | |
| All Schools | 55.2% | 60.9% |
| Public Schools Only | 55.0% | 61.6% |
| Private Schools Only | 57.1% | 53.8% |
| **School-Wide Title I Status Schools** | | |
| Public Schools | 50.6% | 54.3% |
| **National School Lunch Program Schools** | 74.1% | 68.6% |

*NOTE*: In AY20-21, due to COVID-19 USDA waivers, most public schools were providing students with free lunch regardless of whether they reported being part of the National School Lunch Program.

**Table 5.** ***Number of Active U.S. GLOBE Partners That Worked with Formal K-12 Schools 2011-21***

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Partners | 34 | 33 | 30 | 31 | 31 | 52 | 69 | 72 | 74 | 72 | 65 |
| Schools | 194 | 131 | 126 | 103 | 161 | 269 | 423 | 420 | 438 | 325 | 300 |
| New Schools Each Year | 97 | 49 | 45 | 37 | 89 | 155 | 242 | 208 | 191 | 113 | 79 |
| Retained Schools Each Year | 97 | 82 | 81 | 66 | 72 | 114 | 181 | 212 | 247 | 212 | 221 |

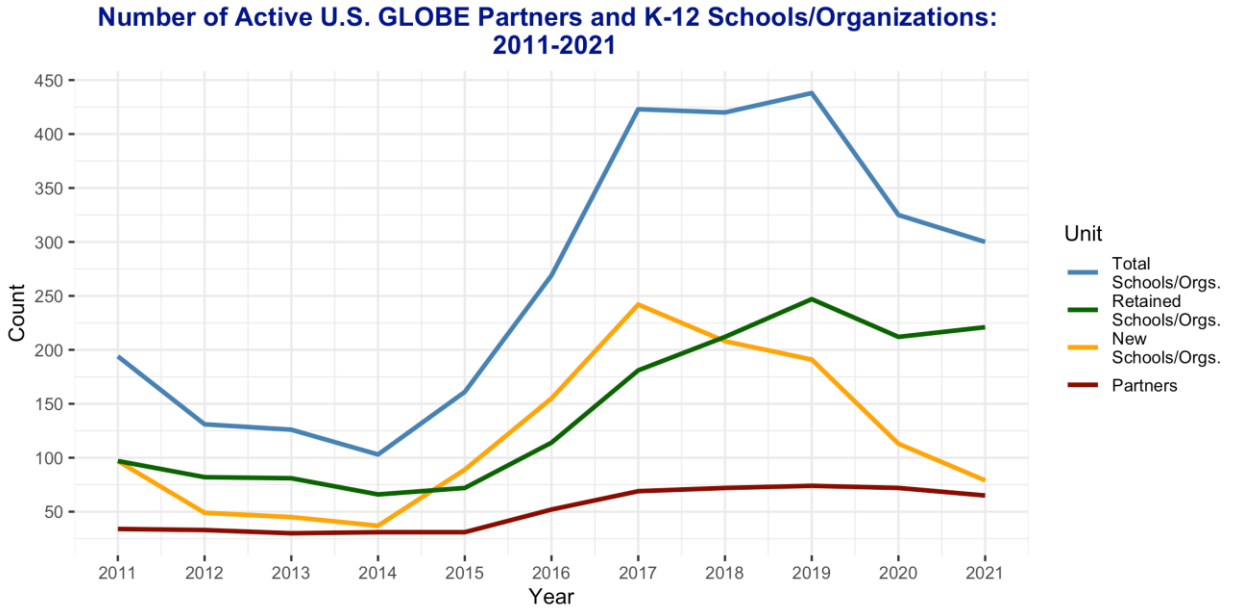



**Figure 2.** ***Number of Active U.S. GLOBE Partners and K-12 Schools Between 2011 and 2021***

**Table 6.** ***Number of Active U.S. GLOBE Partners That Worked with Informal K-12 Schools/Organizations 2011-202***

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Partners | 4 | 3 | 4 | 4 | 9 | 28 | 37 | 39 | 44 | 44 | 43 |
| Organizations | 4 | 3 | 4 | 5 | 16 | 57 | 89 | 114 | 105 | 84 | 91 |

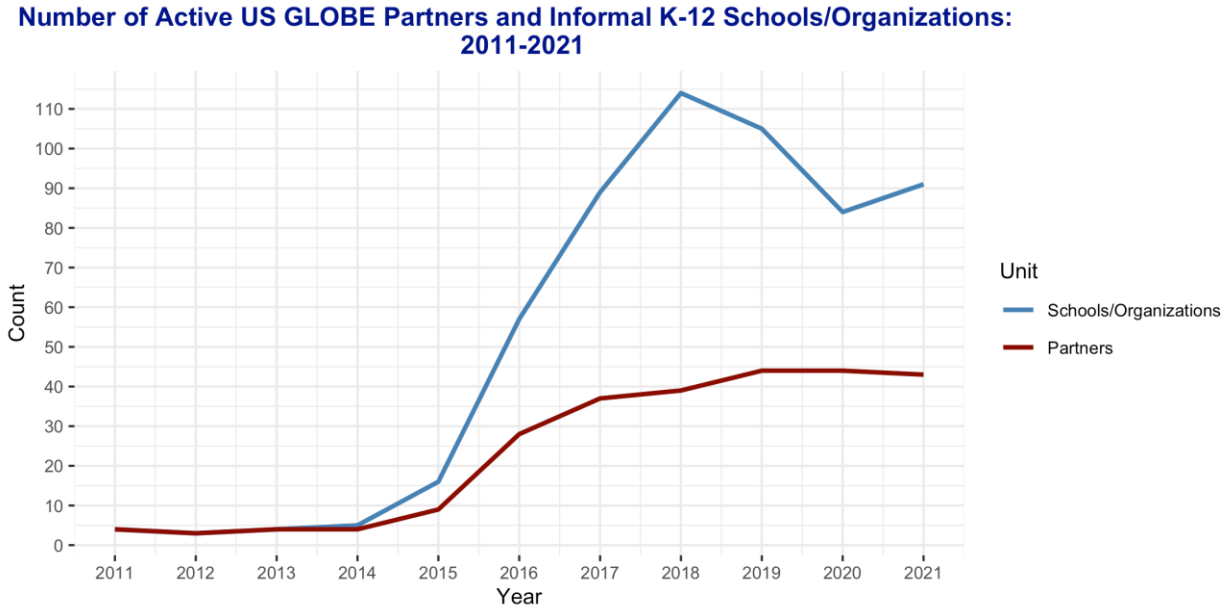



**Figure 3.** ***Number of Active U.S. GLOBE Partners and Informal K-12 Schools Between 2011 and 2021***

The historical data analysis indicated that GLOBE's K-12 reach in the U.S. grew substantially between 2011 and 2021 and that partnerships within the U.S. were widespread and grew within that timeframe, although there are some pockets of opportunity for new partnerships.

An analysis of GLOBE partners and schools or organizations during 2011-2021 was also conducted. Findings indicated that the number of GLOBE partners increased from 2011 to 2018 to 109 and the number of schools nearly doubled in the same time period. Table 7 and Figure 4 illustrate the findings of the international data analysis. Table 8 provides an overview of key takeaways from the historical data analysis.

**Table 7.** ***Number of International GLOBE Partners and Active K-12 Schools/Organizations between 2011 and 2021***

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Partners | 50 | 49 | 47 | 50 | 49 | 94 | 93 | 109 | 108 | 98 | 99 |
| All Schools/Orgs. | 613 | 545 | 461 | 482 | 674 | 865 | 929 | 1192 | 1205 | 996 | 838 |
| Primary Schools | 78 | 72 | 61 | 51 | 56 | 50 | 56 | 46 | 30 | 28 | 25 |
| Secondary Schools | 256 | 245 | 188 | 194 | 253 | 279 | 292 | 299 | 280 | 197 | 163 |
| Primary & Secondary Schools | 135 | 119 | 115 | 106 | 110 | 101 | 114 | 108 | 110 | 86 | 78 |
| No Grade Level | 144 | 109 | 97 | 131 | 255 | 435 | 467 | 739 | 785 | 685 | 572 |

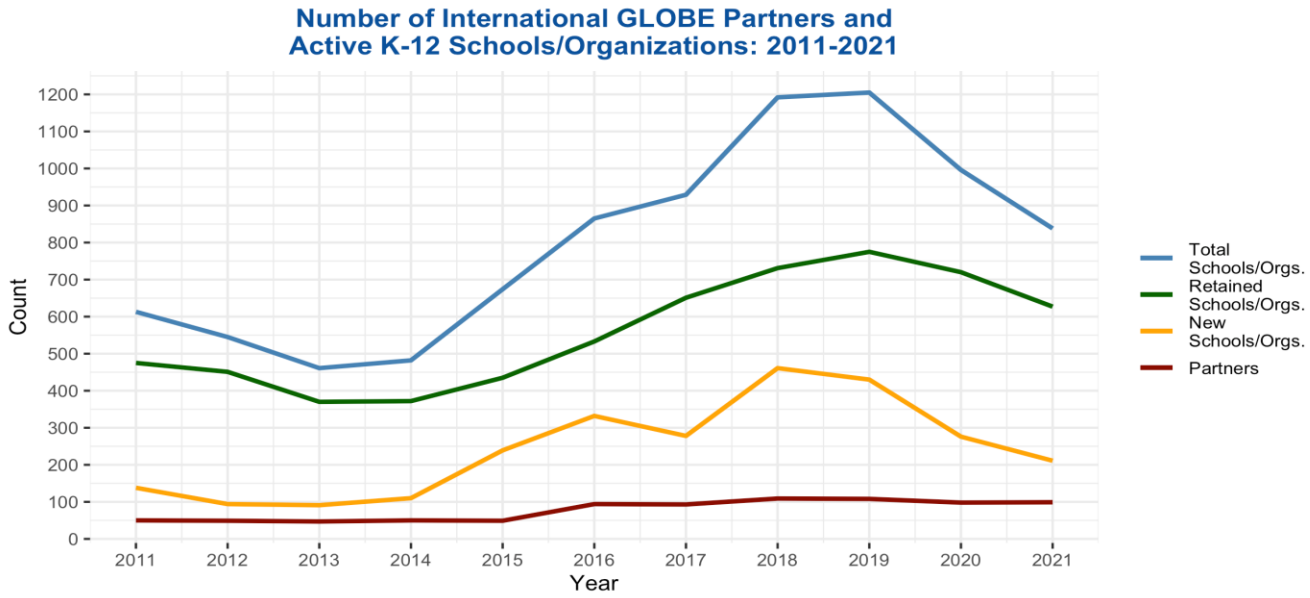



**Figure 4.** ***Number of active International GLOBE partners and informal K-12 schools/organizations between 2011 and 2021***

**Table 8.** ***Historical Data Analysis – Key Takeaways***

| Key Takeaways – Historical Data Analysis |
|---|
| The reach of GLOBE in the U.S. in formal K-12 settings has grown substantially between 2011 and 2021, doubling its footprint in terms of both added active partners and K-12 schools/organizations. |
| The GLOBE historical data reach demographic comparison study also shows increased diversity of active GLOBE schools over time, with increases in participation by urban schools and Title I schools. GLOBE's reach to students from populations historically underrepresented in STEM increased from 2017-18 to 2020-21. |
| School-level demographic data were likely not an entirely accurate representation of GLOBE student participation data since participating teachers and schools did not always submit data regarding the number of student participants, and student demographics were based upon school-level data rather than individual student data. |
| There were active GLOBE partnerships affiliated with formal K-12 institutions and organizations in the vast majority of U.S. states (47) during the time frames examined; the number of active partnerships doubled in number from the 2011-2015 timeframe to the 2016-2021 timeframe. |
| There was a lack of U.S. GLOBE partnerships in some regions of the U.S., including the in the inter-mountain west and northwest (e.g., Idaho, Utah, Washington, Wyoming), some southern states (e.g., Arkansas, Georgia, Missouri, South Carolina), and some states in the eastern U.S. (e.g., Delaware, Kentucky, Rhode Island, South Carolina, District of Columbia). |

# INTERNAL U.S. STAKEHOLDER FORUM

A GLOBE internal stakeholder forum (ISF) was held on June 22, 2022, in order to elicit stakeholder perceptions about GLOBE in the U.S. to inform the program design assessment (PDA) and evaluation design. A total of 31 internal stakeholders attended the four-hour session held on Microsoft Teams. These stakeholders represented a variety of stakeholder groups and included eight K-12 educators representing both formal and informal learning settings, 15 representatives of GLOBE partners, four GLOBE staff members, and four representatives from federal agencies that are GLOBE sponsors.

Three topics were introduced by Paragon TEC evaluation staff. After each of the three topics were introduced, participants were asked to discuss the topics in breakout sessions of about ten participants each. Three of the breakout groups (called "stakeholder groups") were composed of GLOBE partners and educators. The fourth breakout group (called "GLOBE and federal agency staff group") was composed of GLOBE staff and other representatives from federal agencies who engaged in discussions about same the topics discussed by the stakeholder groups but without as specific reference to individual questions. Key Takeaways from the ISF are displayed in Table 9. Discussion topics and questions were as follows:

***Discussion 1: Role of GLOBE in U.S. K-12 Education***

Q1a) What role does GLOBE play in growing the interest and competencies of K-12 students in formal and informal programs in environmental science and research?
Q1b) How do GLOBE K-12 students connect with scientists and what are outcomes of this work?
Q1c) What should be the role of GLOBE in K-12 education in the future?

***Discussion 2: GLOBE Partnerships***

Q2a) How does GLOBE currently engage partners?
Q2b) How have partners enhanced the reach of GLOBE in recent years?
Q2c) How could partnerships be better utilized by GLOBE in the future?

**Discussion 3:** ***Growing Diversity, Equity, & Inclusion***

Q3a) What strategies does GLOBE use to grow participation of underserved and underrepresented students in the program?
Q3b) What should GLOBE be doing to be more inclusive in the future?

**Table 9.** ***Internal Stakeholder Forum- Key Takeaways***

| Key Takeaways – U.S. Internal Stakeholder Forum |
|---|
| Stakeholders identified areas of particular strength for GLOBE including the following:<br>• the role of GLOBE in teaching science skills to K-12 students;<br>• the value of the real-world, hands-on nature of GLOBE learning in engaging student interest;<br>• the value of GLOBE educator training in enhancing educator content knowledge;<br>• the ease of use of protocols that enables educators with little science background to engage students in inquiry learning;<br>• and, the importance of student connections with scientists and other diverse role models.<br>• Partners' play a crucial role as connectors and the "face of GLOBE" at the local level.<br>• GLOBE's expends extensive efforts in engaging a diverse group of students.<br>• GLOBE's invests considerable efforts in lowering the barriers to entry to enable all educators and students to participate in GLOBE. |
| Stakeholders identified areas of potential opportunity for GLOBE to build on its strengths including the following:<br>• including GLOBE in national and state standards and/or using GLOBE nation-wide as a foundational program for teaching science skills;<br>• expanding GLOBE educator training and leverage partnerships with educator professional organizations and pre-service teacher education programs to expand GLOBE's reach;<br>• providing more formalized infrastructure for partnerships;<br>• supporting and expanding the capacity of partners to conduct outreach activities;<br>• building on current successful practices in ensuring that GLOBE is culturally relevant and in lowering barriers to access;<br>• and, expanding the reach of GLOBE by providing more bilingual materials, introducing multidisciplinary content, aligning with career and technical education standards. |

# DOCUMENT CONTENT ANALYSIS

The document analysis reviewed systems-level resources, tools, and evidence which were developed/administered, and/or gathered by the GLOBE Program Office and/or GLOBE Implementation Office and made available to all K-12 GLOBE program participants/sites/partners. The PDA did not include materials developed by partners or schools, or materials developed for localized resources/initiatives.

For the document, evaluators reviewed 122 GLOBE documents, artifacts, and webpages to understand how GLOBE resources, tools, and evidence aligned with effective practices for STEM education programs,

using seven criteria of the STEMWorks Design rubric, a tool that was developed for the purpose of identifying high-quality STEM programs (STEMWorks at WestEd, 2019). These seven criteria were used as a lens with which to understand GLOBE content, and stipulate that high quality STEM programs do the following:

1. Identify and target a compelling and well-defined need
2. Address the needs of underrepresented groups
3. Offer STEM content that is challenging and relevant for the target audience
4. Incorporate and encourage STEM practices
5. Create high-impact partnerships
6. Inspire interest and engagement in STEM
7. Use rigorous evaluation to continuously measure and inform progress in addressing the identified need

Table 10 demonstrates the alignment of the STEMWorks Design Principles with the guiding questions for the GLOBE pre-evaluation activities. Table 11 displays the key takeaways of the document analysis.

***Table 10. Alignment of STEMWorks Design Principles with the Guiding Questions***

| Guiding Questions | STEMWorks Design Principles |
|---|---|
| What is the role of GLOBE in the U.S. education landscape? | • Identify and Target a Compelling and Well-Defined Need (#1)<br>• Address the Needs of Underrepresented Groups (#2)<br>• Inspire Interest and Engagement in STEM (#6) |
| How does GLOBE utilize best practices as determined by STEM education research in their activities? | • Address the Needs of Underrepresented Groups (#2)<br>• Offer STEM Content That is Challenging and Relevant for the Target Audience (#3)<br>• Incorporate and Encourage STEM Practices (#4)<br>• Create High-Impact Partnerships (#5)<br>• Inspire Interest and Engagement in STEM (#6) |
| How has GLOBE expanded their reach in K-12 schools in the U.S. over the past decade? | • Address the Needs of Underrepresented Groups (#2)<br>• Create High-Impact Partnerships (#5) |
| How does GLOBE incorporate evaluation data/evidence in their continuous improvement efforts for K-12 STEM education? | • Use Rigorous Evaluation to Continuously Measure and Inform Progress in Addressing the Identified Need (#7) |

**Table 11.** ***Document Analysis – Key Takeaways***

| Key Takeaways – Document Analysis |
|---|
| ***Criteria #1: The program identifies and targets a compelling and well-defined need*** |
| The GLOBE Program's mission and vision demonstrate that program meets a clear and compelling need as illustrated by both the focus on developing a science-informed citizenry and the future workforce of environmental scientists and specialists. |
| GLOBE has unique value in addressing the established need with the broad domestic and global reach to fulfill its' mission through diverse perspectives. |
| GLOBE does not have a specific focus and/or goal included in the GLOBE Strategic Plan centered on growing talent for the STEM workforce or preparing environmental professionals |
| ***Criteria #2: The program addresses the needs of underrepresented groups*** |
| At the overall program level, GLOBE's Strategic Plan, mission, and vision all focus on global, geographic participation, bringing in variety of backgrounds and cultures. |
| No specific diversity, equity, and inclusion recruitment strategies for U.S. based participants are included in the current GLOBE Strategic Plan goals. |
| There is evidence that GLOBE curricular materials created at local levels can be successfully designed to incorporate a culturally relevant focus, however the limited scope of the review did not permit a deep dive into local adaptations of and locally created GLOBE materials. |
| ***Criteria #3: The Program Offers STEM content that is challenging and relevant for the target audience*** |
| GLOBE curricular materials reviewed provided explicit alignment to Next Generation Science Standards (NGSS). |
| There was evidence that some partners are providing alignments to state learning standards, however because of the limited scope of the review it was not possible to fully understand the extent to which these efforts are being undertaken. |
| GLOBE's use of uniform data collection protocols, guidance on protocol implementation, and the citizen science model that makes student level data available for scientific use suggest the program's high expectations for data collected by GLOBE students of all ages. |
| Elementary GLOBE materials for students in grades K-4 provide a gateway into GLOBE content by using storybooks to engage students in scientific content and challenge them to engage in science activities that prepare them to engage in data collection using GLOBE protocols. |
| The curriculum review suggested that there is potential to provide additional adaptations and scaffolds for student learning levels, however because of the limited scope of the review it was not possible to fully understand the extent to which such efforts are currently being undertaken by GLOBE partners. |
| There is evidence that language translation efforts for curriculum are active and dynamic; since these efforts fall primarily to partners, the limited scope of the review prevented a full understanding off what efforts are made to ensure that materials are translated with attention to cultural values, and how or whether materials are developed with cultural adaptability in mind. |
| ***Criteria #4: The Program incorporates and encourages STEM practices*** |
| The curricular materials reviewed contained evidence of the many inquiry practices, including the following:<br>• carrying out investigations<br>• analyzing and interpretating data<br>• constructing explanations/designing solutions<br>• using mathematics and computational thinking<br>• developing and using models<br>• obtaining and evaluating and communicating information. |

| Key Takeaways – Document Analysis |
|---|
| Less evident within the curricular materials reviewed were the inquiry practices of asking questions/defining problems and engaging in argument from evidence. |
| Although building 21st century skills such as critical thinking, problem-solving, creativity, collaboration, and teamwork are not explicit objectives of the GLOBE program, there is evidence that the program recognizes the importance of and promotes student acquisition of these skills. |
| The degree of student creativity and innovation in GLOBE is highly dependent upon the context in which students participate in the program. Students participating in SRS and IVSS take advantage of opportunities to creatively and innovatively apply their knowledge and skills and GLOBE data to solve authentic problems in their own communities. |
| ***Criteria #5: The program creates high-impact partnerships*** |
| GLOBE has partnered extensively in the U.S. with organizations that have in-house expertise on a wide array of STEM- and educationally related topics and skills that are necessary to effectively conduct the GLOBE program, however it is unknown to what extent the degree or type of partner expertise affects GLOBE programming management and outcomes. |
| GLOBE U.S. partnerships include institutions of higher education, research centers, libraries, school districts, and science centers with longstanding track records of involvement in STEM-related work and education. |
| ***Criteria #6: The program inspires interest and engagement in STEM*** |
| While GLOBE activities incorporate practices that evidence suggests should elicit student interest in STEM, the extent to which the activities achieve interest and engagement was not clear from the document analysis since there has not been a focus on evaluating the role that GLOBE plays in inspiring students along their path of potential interest in science and/or future careers as environmental professionals. |
| Students are given opportunities to connect GLOBE content to their own interests and experiences through SRS and IVSS research. |
| GLOBE curricular materials reviewed made explicit connections to the way scientists work, although references tended to be general rather than to specific careers or individuals. |
| Few resources or supports for educators regarding STEM career opportunities were identified, however the limited scope of the document review did not allow for investigation into resources and supports that may be provided at the partner level. |
| ***Criteria #6: The program uses rigorous evaluation to continuously measure and inform progress in addressing the identified need*** |
| GLOBE has a current Logic Model that details intended outcomes of the program. |
| There is evidence that GLOBE has undertaken rigorous evaluation efforts (i.e., SRI evaluations 1996-2005) and that the program prioritizes the ongoing collection of data through its annual program survey. |
| The program recognizes and is acting on the need for a structured and ongoing approach to understanding program outcomes and impacts. |

# PROGRAM DESIGN ASSESSMENT

The purpose of a program design assessment (PDA) is to develop a baseline assessment of a program regarding one or more of the following: program operational aspects, program curricular aspects, participant data/reach, and program impacts on desired outcomes. The GLOBE PDA focused on program curricular aspects, participant data/reach, and program impacts on desired outcomes. A PDA can then be used to inform an evaluation framework and strategy.

The process of developing the PDA included analyzing the relevant data from previous collection activities

(e.g., Benchmarking Study, Literature Review, Historical Data Reach Report, Internal Stakeholder Forum, Document Content Analysis). Each of these deliverables served as a source of data that were synthesized and evaluated based upon the criteria included in the STEMworks rubric to develop a set of comprehensive key takeaways for GLOBE (Table 12).

**Table 12.** ***GLOBE PDA Key Takeaways - What is Working Well***

| **Identifying a Compelling and Well-Defined Need** |
|---|
| • GLOBE meets a clear and compelling need – developing a science-informed citizenry.<br>• GLOBE has global engagement and participation. |
| **Underrepresented Groups** |
| • GLOBE historical data reach demographic comparison study suggested a diverse representation of GLOBE active U.S. K-12 schools in both calendar? years of study (2017-18 and 2020-21) in terms of urban/rural school communities, school lunch program and Title I schools (schools with high concentrations of poverty), as well as student racial/ethnic backgrounds. |
| **STEM Content** |
| • GLOBE curricular materials reviewed provided explicit alignment to Next Generation Science Standards (NGSS).<br>• GLOBE's use of uniform data collection protocols, guidance on protocol implementation, and the citizen science model that makes student level data available for scientific use suggest the program's high expectations for data collected by GLOBE students of all ages.<br>• GLOBE curriculum includes a central focus on inquiry-based science. |
| **STEM Practices** |
| • GLOBE curriculum includes STEM practices such as: carrying out investigations; analyzing and interpreting data; constructing explanations/designing solutions; using mathematics and computational thinking; developing and using models; and obtaining and evaluating and communicating information. |
| **Partnerships** |
| • GLOBE has partnered extensively with organizations that have in-house expertise on a wide array of STEM- and educationally related topics and skills that are necessary to effectively conduct the GLOBE program.<br>• GLOBE has partnered with institutions of higher education, research centers, libraries, school districts, and science centers with longstanding track records of involvement in STEM-related work and education.<br>• GLOBE historical data reach partnership analyses showed growth of active partners and affiliated K-12 schools/organizations in the U.S. over the last decade. |
| **Inspiring Interest and Engagement in STEM** |
| • Curricular materials make explicit connections to the way scientists work, although references tend to be general rather than to specific careers or individuals. |
| **Rigorous Evaluation** |
| • Data submissions to GLOBE have increased significantly from 2012 to 2022 (~14 million to ~135 million submissions).<br>• Teachers who attend GLOBE professional development opportunities feel more confident and prepared to implement the program. (e.g., SRI reports 1996-2005)<br>• 97% of teachers reported GLOBE changed their instructional practices in one or more ways overall. (SRI report) |

**Table 14.** ***GLOBE PDA Key Takeaways - What Could be Improved***

| Identifying a Compelling and Well-Defined Need |
|---|
| • GLOBE may consider the addition of program-level measures to determine the role GLOBE plays in growing the pathway of future STEM and environmental science talent.<br>• GLOBE may consider including articulation within a U.S. specific GLOBE Strategic Plan recruitment and engagement strategies for specific underrepresented and underserved groups within the U.S. and develop associated performance metrics to purposefully target and measure GLOBE's ability to reach and meet the needs of these groups. |
| **Underrepresented Groups** |
| • GLOBE may consider expanding U.S. annual data collection to include: 1) individual participant-level demographic data, 2) participating school NCES code. |
| **STEM Content** |
| • GLOBE may consider expanding the work in aligning/mapping GLOBE content/instructional materials to U.S. state-level science and mathematics standards.<br>• GLOBE may consider expanding their web-based curriculum/protocols to include more differentiation, scaffolding, and infusion of culturally relevant supports for K-12 educators. |
| **STEM Practices** |
| • Utilize lessons learned from SRS and IVSS to enhance the GLOBE curriculum to include more opportunities for students to extend their GLOBE work with their own investigations into local problems/questions.<br>• Conduct a deeper dive into evaluating the challenges educators face in implementing GLOBE curriculum, protocols, etc. in various settings to understand what additional supports educators may need.<br>• Provide more easily accessible web-based support to teachers in professional development focused on learning how to implement inquiry-based learning pedagogy.<br>• Emphasize 21st century skill development more – particularly collaboration and creativity – within curriculum and protocols |
| **Partnerships** |
| • Although GLOBE reached at least one affiliated K-12 school/organization in every state in the continental U.S. except for Delaware, there was a lack of U.S. GLOBE partnerships in the inter-mountain West (e.g., Idaho, Utah, Wyoming) and several states in the East (e.g., Delaware, Kentucky, Rhode Island, South Carolina, District of Columbia).<br>• GLOBE may consider efforts to achieve a wider distribution of U.S. GLOBE partnerships to reach more of the greater need and less resourced areas/regions. |
| **Inspiring Interest and Engagement in STEM** |
| • Assess the impact of the program on growing K-12 student interest in STEM and associated careers to learn more about the role GLOBE plays in contributing to STEM talent pathways (environmental science talent).<br>• Grow resources for educators related to STEM careers with more easily accessible web-based specific examples and materials for educators to use to introduce students to careers. |
| **Rigorous Evaluation** |
| • Collect more student-level and school-level data (NCES code) from GLOBE participants.<br>• Grow supports for and encourage more detailed data collection on student/learner participation (rather than participation estimates).<br>• Examine barriers for teachers to program implementation to guide PD design, curriculum modifications, and technical support for educators.<br>• Collect actual numbers of participating K-12 students each year. |

- Examine how the program is implemented in formal and informal settings to learn how to better support the variety of approaches to GLOBE and needs of partners/educators.
- Develop an annual program evaluation plan to assess the impact of various levels and durations of participation on student and teacher outcomes and to inform continuous program improvement.

# LIMITATIONS

The pre-evaluation activities were undertaken to provide an overview of the GLOBE program and its practices primarily within the U.S. education landscape. The understanding of GLOBE's materials and activities were based on documentation provided by the program and on information publicly available on the GLOBE website. Findings were limited by the evidence reviewed and should be approached with the understanding that not all the activities conducted by GLOBE partners were represented. Conducting a deep and fine-grained investigation and analysis of GLOBE's work at the partner level was beyond the scope of these tasks. Thus, the PDA findings presented here focused on GLOBE materials available on the program website and on data and materials provided by program staff, with the acknowledgement that all evidence of GLOBE's work in the areas under investigation may not be discoverable by these means.

# REFERENCES

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice (4th ed.).* SAGE.

STEMWorks at WestEd (2019). *STEMWorks Design Principles Rubric.* https://www.sdstemecosystem.org/sites/default/files/201911/STEMworks_Design_Principles_Rubric_0.pdf

*Note: The GLOBE Informal/Formal K-12 Education Program Design Assessment and Evaluation Planning Services were conducted by Paragon TEC. The evaluators appreciate the contributions of the many GLOBE community members that provided perspectives that contributed to the findings of this report.*